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TITLE: DETECTING DEVICE FOR REMAINS SHELL IN SHUCKED SHELLFISH

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ABSTRACT:

PURPOSE: To detect remains shell automatically in a shucked shellfish being
dipped by projecting an X-ray on the shucked shellfish which is being conveyed
in a flow passage by its plug flow and detecting a shell piece according to an
electric signal obtained by converting the X-ray transmitted light from the
shucked shellfish photoelectrically.

CONSTITUTION: The title device is provided with an X-ray tube 2 which generates

a soft X-ray, a shield room 4 which seals the tube 2 electromagnetically, a transportation tube 6 for conveying a short-necked clam, etc., to be inspected by the plug flow, an X-ray sensor 8 which photodetects the X-ray transmitted light from the shucked short-necked clam, and a detection part 10 which detects remains shell according to the detected light. Then the shucked short-necked claw is conveyed to right below the tube 2 and irradiated with the soft X-ray, which is photodetected by the sensor 8; and the photodetected light is converted photoelectrically by the contact type image of the detection part 10. Further, a control part 10 processes the electric signal from a signal processing part into a specific signal, which is outputted as a detection signal to the detection part 10; when the detection signal indicates the remains shell, the shunt plate 15A of a discharging mechanism 15 is inverted and the shell, etc., are discharged from a water tank 16.

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審査請求　未請求　発明の数 1　（全6頁）

⑤4発明の名称　剝身貝中の残殻検出装置

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明　細　書

1．発明の名称

剝身貝中の残殻検出装置

2．特許請求の範囲

調理済の剝身貝中に残存する貝殻片を前記剝身貝が煮汁或いは添加水に浸っている状態で検出する剝身貝中の残殻検出装置において、

前記剝身貝を煮汁或いは添加水と共にプラグ流れで連続搬送させる流路が設けられた搬送手段と、

該搬送手段の流路を貝殻片が残存する剝身貝及び煮汁或いは添加水を流す第1の流路と、貝殻片が残存しない剝身貝及び煮汁或いは添加水を流す第2の流路とに分路する流路切換手段と、

X線を発生し、該X線を前記搬送手段によって搬送中の剝身貝に照射するX線照射手段と、

X線に感光し発光するX線螢光板を有し、該X線螢光板で前記X線照射手段のX線照射に基づく剝身貝のX線透過光を受光する感光手段と、

該感光手段のX線螢光板の発光を電気信号に光電変換する光電変換手段と、

該光電変換手段からの電気信号に基づいて所定の検出信号を出力する信号処理手段と、

該信号処理手段からの検出信号を取り込み、該検出信号が貝殻片を示す場合には該貝殻片の近傍の剝身貝及び煮汁或いは添加水が第1の流路に流れるようにし、前記検出信号が貝殻片を示さない場合には剝身貝及び煮汁或いは添加水が第2の流路に流れるように前記流路切換手段を制御する制御手段と、

を備えたことを特徴とする剝身貝中の残殻検出装置。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は剝身貝中の残殻検出装置に係り、特に剝身貝中に残存する貝殻片を煮汁或いは添加水に浸っている状態で検出する剝身貝中の残殻検出装置に関する。

〔従来の技術〕

通常、剝身貝中の残殻の検出は、貝をボイリン

グした後に剥身にし、煮汁を分離した後水槽に投入して粗大残殻を分離し、そして小さな残殻をメッシュ式コンベア上で目視検査してその分離除去を行っている。

従来の目視検査による剥身貝（例えば、あさり）中の残殻の検出方法を、第3図を参照しながら説明する。第3図に示すように、ボイリング後のあさりは階段状に形成された水槽40、40…内に順次、投入及び搬送され、粗大な貝殻が分離された後、メッシュ式ベルトコンベア42、42に送られる。ベルトコンベア42上では、先ず検査員の目視検査によって剥身あさり中の残殻の検出がされ、又次の工程においてはサーチコイル式の金属探知機44で金属異物等が自動検出される。

ところが、このような目視検査による剥身あさり中の残殻の検出は、剥身内に付刺さったり或いは巻き込まれた状態の残殻の目視確認ができず、又検査員の疲労による見落としや排出ミスを起こす虞がある。又、剥身あさりはメッシュ式ベルトコンベア上で空気にさらされるため、その呈味が低下する問題がある。そこで、このような目視検査による剥身あさり中の残殻検出方式に対して、装置によって自動検出する方式があり、その代表的な方式としては超音波検査方式、電磁検査方式及び軟X線検査方式がある。

〔発明が解決しようとする問題点〕

しかしながら、このような自動検査方式が適用される各装置においては、種々の問題がある。超音波検査方式の装置では剥身あさりと残殻との区別が容易にできない不具合がある。電磁検査方式の装置では金属以外の異物検出が難しく、非磁性金属の検出精度も悪くS／Nが悪いため剥身貝のような残殻検出装置に適用するのが困難となっている。

又、軟X線検出方式の装置では各種の異物の認識ができるので貝以外の食品の異物検出に大きな実績があるが、あさり等の貝類の残殻検出に適応した場合には残殻と剥身あさりとのX線吸収差はそれほど大きくないため、その残殻検出の信号処理が困難となっている。更に、残殻と剥身あさり及び煮汁或いは添加水とを分離する有効な方法がないために、今だに軟X線検査方式を用いた剥身貝中の残殻検出装置の自動化がされていない。

本発明はこのような事情に鑑みてなされたもので、煮汁或いは添加水に浸ったままの剥身貝中から残殻を自動的に検出することができる剥身貝中の残殻検出装置を提供することを目的としている。

〔問題点を解決するための手段〕

本発明は前記目的を達成するために、調理済の剥身貝中に残存する貝殻片を前記剥身貝が煮汁或いは添加水に浸っている状態で検出する剥身貝中の残殻検出装置において、前記剥身貝を煮汁或いは添加水と共にプラグ流れで連続搬送させる流路が設けられた搬送手段と、該搬送手段の流路を貝殻片が残存する剥身貝及び煮汁或いは添加水を流す第1の流路と、貝殻片が残存しない剥身貝及び煮汁或いは添加水を流す第2の流路とに分路する流路切換手段と、X線を発生し、該X線を前記搬送手段によって搬送中の剥身貝に照射するX線照射手段と、X線に感光し発光するX線蛍光板を有し、該X線蛍光板で前記X線照射手段のX線照射に基づく剥身貝のX線透過光を受光する感光手段と、該感光手段のX線蛍光板の発光を電気信号に光電変換する光電変換手段と、該光電変換手段からの電気信号に基づいて所定の検出信号を出力する信号処理手段と、該信号処理手段からの検出信号を取り込み、該検出信号が貝殻片を示す場合には該貝殻片の近傍の剥身貝及び煮汁或いは添加水が第1の流路に流れるようにし、前記検出信号が貝殻片を示さない場合には剥身貝及び煮汁或いは添加水が第2の流路に流れるように前記流路切換手段を制御する制御手段と、を備えたことを特徴としている。

〔作用〕

本発明に係る剥身貝中の残殻検出装置では、調理済の剥身貝及び煮汁或いは添加水は搬送手段の流路にプラグ流れで連続的に搬送され、この流路は流路切換手段によって貝殻片が残存する又は残存しない剥身貝及び煮汁或いは添加水を流す第1の流路と第2の流路とに分路される。

搬送中の剖身貝にはX線照射手段からのX線が照射され、剖身貝のX線透過光は感光手段のX線螢光板で受光される。この受光に伴ってX線螢光板から発生する光は光電変換手段によって光電変換され、信号処理手段はこの光電変換手段からの電気信号に基づいて所定の検出信号を出力する。制御手段は信号処理手段からの検出信号を取り込み、この検出信号が貝殻片を示す場合にはこの貝殻片が残存する剖身及び煮汁或いは添加水が第1の流路に流れるようにし、検出信号が貝殻片を示さない場合には剖身貝及び煮汁或いは添加水が第2の流路に流れるように流路切換手段を制御する。

これにより煮汁或いは添加水に浸ったままの剖身貝中から残殻を自動的に検出できると共に剖身が直接、空気に触れないので呈味が失われない。

〔実施例〕

以下、添付図面に従って本発明に係る剖身貝中の残殻検出装置の好ましい実施例を詳説する。

第1図及び第2図に本発明に係る剖身貝中の残殻検出装置の全体構成を示す。尚、第1図は装置の上面図、第2図は装置の側面図をそれぞれ示す。

第1図及び第2図に示す剖身貝中の残殻検出装置は軟X線検査方式が採用されており、同図において装置は軟X線を発生するX線管2と、このX線管2を収納し電磁密閉する密閉シールドルーム4と、被検査物であるあさり及び煮汁或いは添加水のプラグ流搬送を行うための短形パイプライン式輸送チューブ（以下、輸送チューブと略称する）6と、剖身あさりのX線透過光（像）を受光するX線センサ8と、X線センサ8の受光に基づいて残殻を検出する検出部10と、軟X線の外部への拡散を防止する全体遮蔽ボックス12と、検出部10からの検出信号に基づいて剖身あさりの残殻及び残殻付きあさりを選択して排出する排出部14と、排出部14からの残殻及び残殻付きあさり（煮汁或いは添加水を含む）を収容する水槽16と、排出部14からの剖身あさり及び煮汁或いは添加水を収容する水槽18とから構成されている。

又、本装置には図示しない電源、制御ボックス、剖身あさりの搬送を行うロータリーポンプ、及び軟X線の非照射部で剖身あさりを投入するタンク及びこれらを収納する密閉シールドルームが設けられている。更に、輸送チューブ6が通されている全体遮蔽ボックス12の開口部12A、12Bには、軟X線の外部への拡散を防止する図示しない鉛ゴム性のX線遮蔽スクリーンが多重設置されている。

輸送チューブ6は内径高さ15㎜、底辺長さ30㎜、斜辺傾斜角30度にそれぞれなるように形成される。また、輸送チューブ6には低X線吸収率の材料が使用されている。このような輸送チューブ6等によって構成される搬送系は、X線管2の発信周波数の1周期分（20ms）に同期させて、剖身あさりのプラグ流搬送を行うと共に間欠搬送しながらワークである前記剖身あさりに軟X線が照射されるようにする。

X線センサ8には希土類系の蛍光体が形成されたX線蛍光板が用いられており、その蛍光体の両面に電極を介してDC350Vの高電圧が印加される。このX線蛍光板8はX線像を低X線強度（例えば80kV、5mA）で、しかも高感度且つ高解度にエレクトロルミネンセンス表示できる特性を有している。又、X線蛍光板8は軟X線の周期変動を丸め込み、更に軟X線の放射角に起因する前記パイプライン6の影の影響を相殺すると共にX線透過光を受けてその蛍光体が発光する。

検出部10はX線蛍光板8の発光を光電変換する光電変換素子、光電変換素子からの電気信号に基づいて残殻を検出する信号処理部及び信号処理部からの検出信号に基づいて排出部14を制御する制御部から構成されている。

光電変換素子としては例えば密着型イメージセンサ（80画素、500μm角／画素）が用いられる。密着型イメージセンサは、X線管2の発信周波数の1周期分（20ms）に同期してX線透過光を積分蓄積してS／Nを向上させると共に軟X線の周期変動を丸め込む。また、密着型イメージセンサはこの積分値を所定の電気信号に変換し（飽和レベル2V）、信号処理部に出力する。

信号処理部はこの電気信号をサンプルアンドオールド処理して連続信号に変換する。そして、その連続信号中の指定ゲイン（例えば１００ｍＶ）以上のピーク値を検出することで剖身あさり中の残殻を検出することができる。尚、本実施例では剖身あさり中の残殻を約２０ms／ラインで自動検出することができるようになっている。信号処理部は剖身あさり中に残存する貝殻片の検出に伴って検出信号を制御部に出力する。制御部はこの検出信号を受けて残殻の排出を指示する排出信号を排出部１４に出力する。

排出部１４は制御部からの排出信号に基づいて、輸送チューブ６中の残殻が検知された近傍の剖身あさり及び煮汁或いは添加水を輸送ラインより分離して系外に高速且つ簡便に排出させる。この排出部１４は２点鎖線１５で概念的に示す排出機構によって駆動される自動二方板方式の流路切り換え機構を有している。排出機構は制御部からの排出信号に基づいて動作する図示しない駆動部によって制御されるようになっている。また、流路切り換え機構には、流路を２方向に分路する分路板１５Ａが設けられている。この分路板１５Ａは残殻が検出された場合にはその向きが図示と反対の方向に切り換わり、これにより貝殻及び貝殻片が残存する剖身あさりが水槽１６側に落下するようになっている。その際、剖身あさりに対して約３倍の煮汁或いは添加水で搬送処理した場合、自動二方板方式の流路切り換え時間は約２００ms程度で済み、又、１排出当り約５ｇの極少量の排出量で残殻が排出される。

装置本体の外径寸法としては、幅５５０㎜×高さ８００㎜×奥行き５５００㎜程度で、総重量としては約１００kg程度である。

次に、前記の如く構成された剖身貝中の残殻検出装置の動作について述べる。

タンクに投入された調理済の剖身あさりはロータリポンプによって輸送チューブ６に搬入され、間欠的にプラグ流搬送される。剖身あさりはＸ線管２の真下に搬送されるとその間欠搬送の周期に同期してＸ線が照射され、剖身あさりのＸ線透過光がＸ線螢光板８によって受光される。Ｘ線螢光板８の受光に伴ってその螢光面から発生する光が検出部１０の密着型イメージによって光電変換され、Ｘ線透過光に応じた電気信号が信号処理部に出力される。信号処理部はこの電気信号を所定の信号に処理し、その信号レベルに応じた検出信号を制御部に出力する。制御部は検出信号に基づいて、その検出信号が残殻を示す場合には、排出部１４の駆動部に排出信号を出力し排出機構１５の分路板１５Ａが図示と逆の方向に反転するように制御する。これにより、貝殻及び貝殻片が残存する剖身あさり及び煮汁或いは添加水が水槽１６側に排出される。

以上、述べたように本実施例の剖身貝中の残殻検出装置では、剖身あさりを煮汁或いは添加水と共に間欠的にプラグ搬送させると共に、その剖身あさりのＸ線透過光に基づいて得られる電気信号を信号処理して剖身あさり中の残殻を自動的に検出し、残殻が検出された場合にはその残殻が検出された剖身あさり及び煮汁或いは添加水を系外に排出するようになっている。

これにより、剖身あさりの呈味を失うことなく残殻を精度よく高速に検出することが可能である。

又、本装置の一般性能としては残殻で１ｍｍ角、硬球で直径約０．５㎜まで認識でき、従来の単純な蛍光板を用いた検出装置に比べ、更に１ランク細かい異物認識が可能である。

〔発明の効果〕

以上説明したように本発明に係る剖身貝中の残殻検出装置では、調理済の剖身貝中に残存する貝殻片を前記剖身貝が煮汁或いは添加水に浸っている状態で検出する剖身貝中の残殻検出装置において、流路に剖身貝を煮汁或いは添加水と共にプラグ搬送させると共にＸ線を照射し、その剖身貝のＸ線透過光の光電変換によって得られる電気信号に基づいて貝殻片を検出し、貝殻片が検出された場合には流路を切り換えて貝殻片の近傍の剖身貝及び煮汁或いは添加水を排出するようにしたので、煮汁或いは添加水に浸ったままの剖身貝中から残殻を自動的に検出することができる。

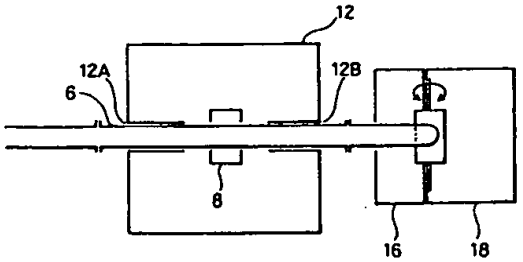
4．図面の簡単な説明

第1図は本発明に係る剖身貝中の残殻検出装置の全体構成を示す上面図、第2図は本発明に係る剖身貝中の残殻検出装置の全体構成を示す側面図、第3図は従来の剖身貝中の残殻検出方法の説明図である。

2…X線管、　4…密閉シールドルーム、　6…パイプライン式輸送チューブ、　8…X線センサ、　10…全体遮蔽ボックス、　12…排出部、　14、16…水槽。

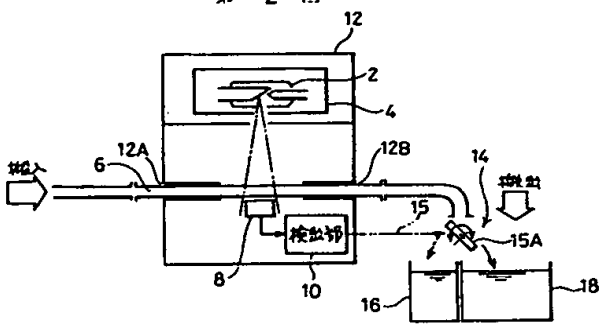
出願人　日立プラント建設株式会社

第　1　図

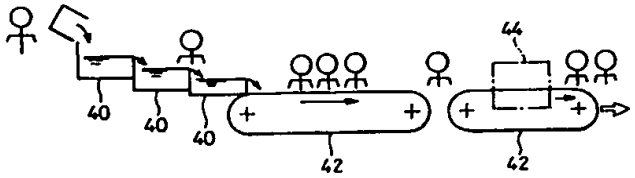


2：X線管
4：密閉シールドルーム
6：パイプライン式輸送チューブ
8：X線センサ
10：全体遮蔽ボックス
12：排出部
14,16：水槽

第　2　図



第　3　図



第1頁の続き

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DETECTING DEVICE FOR SHELL REMAINS IN SHUCKED SHELLFISH

(Mukizikai chu no Zangara Kenshutsu Sochi)

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SPECIFICATION /1[1]

I. Title of the Invention

Detecting Device for Shell Remains in Shucked Shellfish

II. Claims

1. A detecting device for remains shell in a shucked shellfish
which detects remaining shell pieces in a prepared shucked shellfish in a state of dipping said shucked shellfish in its stock or added water is characterized by having
a carrying means provided with a flow passage which continuously carries the said shucked shellfish with its stock or added water by a plug flow,
a flow passage switching means which shunts the flow passage of said carrying means into a first flow passage for allowing the shucked shellfish with remains shell and its stock or added water to flow and a second flow passage for allowing the shucked shellfish without remains shell and its stock or added water to flow,
an X-ray irradiating means which generates an X-ray and irradiates the X-ray on the shucked shellfish in carrying by

[1] Numbers in the margin indicate pagination in the foreign text.

said carrying means,

a photosensitive means which has an X-ray fluorescent plate for sensitization to the X-ray to emit a light and receives an X-ray transmitted light of said shucked shellfish based on the X-ray irradiation of said X-ray irradiation means by said X-ray fluorescent plate,

a photoelectric converting means which photoelectrically converts the light emission of X-ray fluorescent plate of said sensitizing means to an electric signal,

a signal processing means which outputs a predetermined detection signal based on the electric signal from said photoelectric converting means, and

a control means which intakes the detection signal from said signal processing means and controls the said flow passage switching means so that the shucked shellfish in the vicinity of shell pieces and its stock or added water flow in the first flow passage when the said detection signal indicates shell pieces and the shucked shellfish and its stock or added water flow in the second flow passage when the said detection signal does not indicate shell pieces.

III. Detailed Description of the Invention

[Field of Industrial Application]

This invention relates to a detecting device for remains

shell in a shucked shellfish, and particularly to a detecting device for remains shell in a shucked shellfish which detects the shell pieces remaining in the shucked shellfish in a state of dipping the shell pieces in its stock or added water.

[Prior Art]

Usually, the detection of remains shell in a shucked shellfish

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is performed in such a way that a shellfish is boiled and then shucked, after a stock is separated, put into a water tank to separate a coarse remains shell, then small remains shell is separated and removed on a mesh type conveyer by visual inspection.

A prior detection method of remains shell in a shucked shellfish (e. g., a short-necked clam) by visual inspection will be illustrated while seeing Fig. 3. As shown in Fig. 3, the short-necked clam after boiling is put and carried sequentially into water tanks **40**, **40** ... formed stepwise and, after a coarse shell is separated, delivered by mesh belt conveyers **42**, **42**. On the belt conveyers **42**, remains shell in the shucked short-necked clam is detected by visual inspection of an inspector and then metal foreign matters are automatically detected by a search coil type metal detector **44** in the next process step.

For such a detection of remains shell in the shucked short-

necked clam by visual inspection, however, it is feared that the visual confirmation of remains shell cannot be made in a stuck or wound state in a shucked shellfish or the overlook due to fatigue of inspector or a discharge mistake occurs. Moreover, the shucked short-necked clam is exposed to air on the mesh belt conveyer, there is a problem that its taste deteriorates. Accordingly, for such remains shell detection modes in the shucked short-necked clam by visual inspection, a mode of automatic detection by an equipment, an ultrasonic inspection mode, an electromagnetic inspection mode and a soft X-ray inspection mode are given as its typical modes.

[Problems to Be Solved by the Invention]

However, various problems exist in devices applied with such an automatic inspection modes. In a device of the ultrasonic inspection mode, there is an inconvenience that the shucked short-necked clam and the remains shell cannot be easily differentiated. In the electromagnetic inspection mode, the inspection of foreign matters other than metals is difficult, the detection accuracy of non-magnetic metals and the S/N are also bad, therefore it becomes difficult to apply the modes to such a detecting device for remains shell of shucked short-necked clam.

Because various foreign matters can be recognized by the soft X-ray detection mode, it gives great results in foreign matter detection of food other than shellfish, but when it is

applied to the remains shell detection of shellfish such as short-necked clam, etc., the X-ray absorption difference between the remains shell and the shucked shellfish is not so big, therefore signal processing of said remains shell detection becomes difficult. Moreover, there is no effective method for separating the remains shell and the shucked short-necked clam as well as its stock or added water, therefore the detecting device for remains shell of shucked shellfish using the soft X-ray detection mode has not been automated so far.

This invention was made in view of such a circumstance and is aimed at providing a detecting device for remains shell of a shucked shellfish which enables to automatically detect the remains shell in the shucked shellfish while dipping in its stock or added water.

[Means for Solving the Problems]

To achieve said purpose, this invention is characterized by that in a detecting device for remains shell in a shucked shellfish which detects shell pieces remaining in a prepared shucked shellfish in a state of dipping said shucked shellfish in its stock or added water, the said detecting device has a carrying means provided with a flow passage which continuously carries a shucked shellfish with its stock or added water by a plug flow, a flow passage switching means which shunts the flow passage of said carrying means into a first flow passage for

allowing the shucked shellfish with remains shell and its stock or added water to flow and a second flow passage for allowing the shucked shellfish without remains shell and its stock or added water to flow, an X-ray irradiating means which generates an X-ray and irradiates the X-ray on the shucked shellfish in carrying by said carrying means, a photosensitive means which has an X-ray fluorescent plate for sensitization to the X-ray to emit a light and receives an X-ray transmitted light of said shucked shellfish based on the X-ray irradiation of said X-ray irradiation means by said X-ray fluorescent plate, a photoelectric converting means which photoelectrically converts the light emission of X-ray fluorescent plate of said sensitizing means to an electric signal,

a signal processing means which outputs a predetermined detection signal based on the electric signal from said photoelectric converting means, and a control means which intakes the detection signal from said signal processing means and controls the said flow passage switching means so that the shucked shellfish in the vicinity of said shell pieces and its stock or added water flow in the first flow passage when the said detection signal indicates shell pieces and the shucked shellfish and its stock or added water flow in the second flow passage when the said detection signal does not indicate shell pieces.

[Functions]

In the detecting device of remains shell in a shucked shellfish relating to this invention, the prepared shucked shellfish and its stock or added water are continuously carried by a plug flow in the flow passage of the carrying means, and this flow passage is shunted into the first flow passage and the second flow passage where the shucked shellfish with or without remaining shell pieces and its stock or added water are allowed to flow by the flow passage switching means.

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The X-ray from the X-ray irradiating means is irradiated on the shucked shellfish which is being carrying, and the X-ray transmitted light of said shucked shellfish is received by the X-ray fluorescent plate of said photosensitizing means. A light generated from the fluorescent plate associated with the reception is photoelectrically converted by the photoelectric converting means, and the signal processing means outputs a predetermined detection signal based on the electric signal from this photoelectric converting means. The control means intakes the detection signal from the signal processing means to control the flow passage switching means so that the shucked shellfish with remaining shell pieces and its stock or added water flow in the first flow passage when this detection signal indicates the shell pieces and the shucked shellfish without remaining shell pieces and its stock or added water flow in the second flow

passage when this detection signal indicates no shell pieces.

This enables to automatically detect the remains shell from the shucked shellfish while dipping in its stock or added water and also does not lose the taste because the shucked shellfish is not directly brought into contact with air.

[Actual Example]

A preferable actual example of the detecting device for remains shell in the shucked shellfish relating to this invention will be illustrated in detail according to drawings below.

The whole constitution of said detecting device for remains shell in the shucked shellfish relating to this invention is shown in Fig. 1 and Fig. 2. Moreover, Fig. 1 shows the top view of device, and Fig. 2 shows the side view of device, respectively.

A soft X-ray detection mode is adopted in the detecting device for remains shell in the shucked shellfish shown in Fig. 1 and Fig. 2 where the device comprises an X-ray tube **2** which generates a soft X-ray, a closely sealed drum **4** which contains and electromagnetically closes this X-ray tube **2**, a short pipeline type conveying tube (abbreviated as "conveying tube" hereafter) **6** for performing a plug flow carrying of short-necked clam being object to be inspected and its stock or added water, an X-ray sensor **8** which receives an X-ray transmitted light (image) of said shucked short-necked clam, a detection part **10**

which detects remains shell based on light reception of said X-ray sensor **8**, a wholly-shielding box **12** which prevents the soft X-ray from diffusion to the outside, a discharge part **14** which selects and discharges the remains shell of said shucked short-necked clam and the short-necked clam with remains shell based on the detection signal from the detection part **10**, a water tank **16** which receives the remains shell and the short-necked clam with remains shell (including its stock or added water) from the discharge part **14**, and a water tank **18** which receives the shucked short-necked clam and its stock or added water from the discharge part **14**.

Moreover, non-illustrated a power supply, a control box, a rotary pump which performs the carrying of said shucked short-necked clam, a tank charged with the shucked short-necked clam in a non-irradiating part of soft X-ray and a closely sealed drum receiving it are provided in this device. Furthermore, multiple non-illustrated lead rubber X-ray shielding screens which prevents the soft X-ray from diffusion to the outside are disposed in the opening **12A**, **12B** of said wholly-shielding box **12** through which the conveying belt **6** passes.

The conveying tube **6** is so formed as to become the inner diameter (height) 15 mm, bottom side length 30 mm and inclination angle of oblique line 30°, respectively. A material of low X-ray absorptivity is used for the conveying tube **6**. In the carrying

system constructed by such a conveying tube **6**, a soft X-ray is irradiated on said shucked short-necked clam being a work while intermittently carrying and performing the plug flow of said shucked short-necked clam in synchronism with one period (20 ms) of the transmission frequency of said X-ray tube **2**.

An X-ray fluorescent plate formed with a rare-earth fluorophore is used in the X-ray sensor **8**, and a high voltage of DC 350 V is applied to both faces of the fluorophore via electrodes. This X-ray fluorescent plate **8** has a characteristic which can display an X-ray image by electroluminescence at a low X-ray intensity (e. g., 80 kV, 5 mA), high sensitivity and high brightness. Moreover, the X-ray fluorescent plate **8** coaxes the periodical fluctuation of soft X-ray, offsets an influence of shadow of said pipeline **6** caused by the radiation angle of said soft X-ray and receives an X-ray transmitted light to make this fluorophore emit a light.

The detection part **10** comprises a photoelectric converting element, a signal processing part which detects the remains shell based on the electric signal from the photoelectric converting element and a control part which controls the discharge part **14** based on a detection signal from the signal processing part.

For example, a contact type image sensor (80 image elements, 500 μm angle/image element) is used as the photoelectric converting element. The contact type image sensor integrally

accumulates the X-ray transmitted light to improve the S/N and coax the periodical fluctuation of said soft X-ray in synchronism with one period of transmission frequency of said X-ray tube **2**. Moreover, the contact type image sensor converts this integral value to a predetermined electric signal (saturation level 2V) and outputs it to the signal processing part.

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The signal processing part converts this electric signal to a continuous signal by sample-and-hold processing. Then, remains shell in the shucked short-necked clam can be detected by detecting a peak value of over an assigned gain (e. g., 100 mV) in the continuous signal. Moreover, the remains shell in the shucked short-necked clam can be automatically detected at about 20 ms/line in this actual example. The signal processing part outputs a detection signal to the control part with the detection of shell pieces remaining in the shucked short-necked clam. The control part receives this detection signal and outputs a discharge signal which instructs the discharge of said remains shell to the discharge part **14**.

The discharge part **14** separates the nearby shucked short-necked clam with detected remains shell in the conveying tube **6** and its stock or added water and discharges them from the system simply and at a high speed based on the discharge signal from the control part. This discharge part **14** has a flow passage switching

mechanism which is driven by a discharge mechanism conceptually shown by a two-chain line **15** and switches the flow passage by automatic two-way plate mode. The discharge mechanism is controlled by a non-illustrated driving part that operates based on the discharge signal from the control part. Moreover, a shunt plate **15A** that shunts the flow passage into two ways is provided in the flow passage switching mechanism. When remains shell are detected, the orientation of this shunt plate **15A** is switched to a direction opposite to illustrated direction, thereby the shell and shucked short-necked clam with remaining shell pieces flow down to the water tank **16** side. At this time, when they are conveyed and processed in about 3 times of stock or added water to the shucked short-necked clam, the flow passage switching time by said automatic two-way plate mode is finished with about 200 ms, or the remains shell is discharged at a very small discharge quantity of about 5 g per discharge.

The outer diameter dimensions of said device body are about width 550 mm x height 800 mm x depth 5,500 mm, and the total weight is about 100 kg.

Subsequently, operations of the detecting device of remains shell in a shucked shellfish constructed as described above will be described.

A prepared shucked short-necked clam put into a tank is moved into the conveying tube **6** by the rotary pump and then

conveyed intermittently by a plug flow. The shucked short-necked clam is conveyed right below the X-ray tube and a soft X-ray is irradiated in synchronism with the period of said intermittent conveying, and the X-ray transmitted light of said shucked short-necked clam is received by the X-ray fluorescent plate **8**. A light generated from the fluorescent plane with the light reception of said X-ray fluorescent plate **8** is converted photoelectrically by the contact type image sensor of said detecting part **10** and an electric signal corresponding to the X-ray transmitted light is output to the signal processing part. The signal processing part processes this electric signal to a predetermined signal and outputs a detection signal corresponding to this signal level to the control part. When this detection signal indicates remains shell, the control part outputs a discharge signal to the driving part of said discharge part **14** and controls the shunt plate **15A** of said discharge mechanism **15** based on the detection signal so as to invert it in a direction contrary to the illustrated direction. Thereby, shucked short-necked clam with remains shell, shell pieces and its stock or added water are discharged to the water tank **16** side.

As described above, in the detecting device for remains shell in a shucked shellfish of this actual example, the shucked short-necked clam is conveyed intermittently with its stock or added water, an electric signal obtained based on the X-ray

transmitted light of said shucked short-necked clam is processed to automatically detect remains shell in the shucked short-necked clam and, when the remains shell are detected, the shucked short-necked clam with the detected remains shell and its stock or added water are discharged from the system.

It enables to detect the remain shell in a good accuracy and at a high speed without losing the taste of said shucked short-necked clam.

Moreover, as general performances, this device can recognize a 1 mm (wrong unit "1 m" in original specification, translator) square remains shell and a 0.5 mm-diameter hard ball, thus it can recognize foreign matters as fine as one more rank.

[Effects of the Invention]

As described above, the detecting device for remains shell in a shucked shellfish relating to this invention enables to automatically detect remains shell from shucked shellfish while it is dipped in its stock or added water because the shucked shellfish and its stock or added water are conveyed by a plug flow in a flow passage and an X-ray is irradiated, shell pieces are detected based on an electric signal obtained by photoelectric conversion of an X-ray transmitted light of said shucked shellfish and, when the shell pieces are detected, the flow passage is switched to discharge the shucked shellfish nearby the shell pieces and its stock or added water

in the detecting device for detecting shell pieces remaining in prepared shucked shellfish in a state of dipping said shucked shellfish in its stock of or added water.

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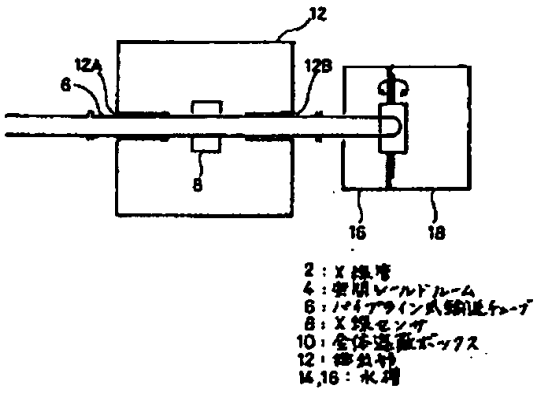
IV. Brief Description of the Drawings

Fig. 1 is top view showing whole constitution of detecting device for remains shell in shucked shellfish relating to this invention, Fig. 2 is side view showing whole constitution of detecting device for remains shell in shucked shellfish relating to this invention, and Fig. 3 is illustrative diagram of conventional detection method of remains shell in shucked shellfish.

第 1 図



第 2 図

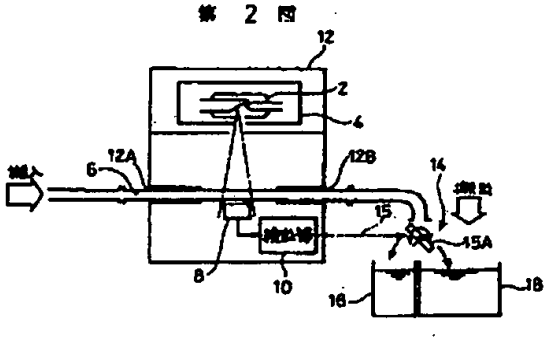


FIGURE 1 KEY:

2	...	X-ray tube
4	...	closely sealed drum
6	...	pipeline type conveying tube
8	...	X-ray sensor
10	...	wholly-shielding box
12	...	discharge part
14, 16	...	water tanks

FIGURE 2 KEY:

(from left to right)

carrying in detection part carrying out

Figure 3: